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# Predicting the Yield of Fat, Bone and Edible Portion from Pork Carcasses

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# PREDICTING THE YIELD OF FAT, BONE AND EDIBLE PORTION FROM PORK CARCASSES


BY

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PREDICTING THE YIELD OF FAT, BONE AND EDIBLE

PORTION FROM PORK CARCASSES

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Doctor of Philosophy, and is acceptable as meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Adviser Date

Major Adviser Date

Head, Animal Science Department

PREDICTING THE YIELD OF FAT, BONE AND EDIBLE
PORTION FROM PORK CARCASSES
Abstract

DANIEL H. GEE

Under the supervision of Professor R. C. Wahlstrom

Studies designed to investigate the accuracy of predicting total edible portion weight from a pork carcass were conducted over a two-year period. One hundred fifty crossbred pigs of predominant Hampshire-Yorkshire breeding weighing an average of 203.2 ± 5.1 pounds were used in this study. The pigs were 160.8 ± 11.0 days of age at slaughter, had an average of 1.39 inches of carcass backfat and 4.51 square inches of longissimus dorsi area. The following measurements were collected in the cooler and used in an attempt to predict total pounds of edible portion: animal age at slaughter, weight off test, slaughter weight, carcass length, average carcass backfat, longissimus dorsi area and chilled carcass weight. In addition, head weight, viscera weight, leaf fat weight and several fat probe measurements were collected and used. Both the right and left sides of each carcass were divided into fat, bone and edible portion components. Simple correlation coefficients between the various carcass measurements and total pounds of edible portion were calculated. Correlation coefficients between total edible portion weight and leaf fat weight, average carcass backfat and longissimus dorsi area were -.42 ($P<.01$), -.62 ($P<.01$) and 0.58 ($P<.01$), respectively. The two fat thickness measurements taken between the 12th and 13th ribs at one-fourth and one-half the length of the longissimus dorsi muscle from the chine bone end showed

high correlation coefficients with total edible portion weight ($r = -.56$ and $-.56$). The highest correlation coefficients between the various fat probes and pounds of edible portion were the probes taken in the area of the lumbar vertebrae ($r = -.43$ and $-.48$). Correlation coefficients between pounds of edible portion and animal age at slaughter, slaughter weight, carcass length and chilled carcass weight were $-.15$, 0.21 ($P < .01$), 0.21 ($P < .01$) and 0.54 ($P < .01$), respectively. Chilled carcass weight averaged $149.4 \pm 4.1$ pounds and the total fat weight from each carcass averaged $36.5 \pm 5.0$ pounds. Multiple regression analyses were made to provide prediction equations for estimating total pounds of edible portion and total fat weight. Among the equations to predict fat weight were (1) $Y = 6.41 + 1.61$ (average carcass backfat thickness) + 1.32 (leaf fat weight) - 1.81 (*longissimus dorsi* area) + 0.21 (chilled carcass weight), $R = .883$ and (2) $Y = 36.26 + 1.68$ (average carcass backfat thickness) + 1.29 (leaf fat weight) - 1.47 (*longissimus dorsi* area), $R = .867$. The total edible portion weight from each carcass averaged $92.2 \pm 4.7$ pounds. The following equations can be used to predict edible portion: (1) $Y = 10.89 - 1.16$ (average carcass backfat thickness) + 0.57 (chilled carcass weight) + 2.70 (*longissimus dorsi* area) $-.09$ (animal age at slaughter), $R = .881$ and (2) $Y = -6.37 - 1.21$ (average carcass backfat thickness) + 0.61 (chilled carcass weight) + 2.01 (*longissimus dorsi* area), $R = .869$.

## ACKNOWLEDGMENTS

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# INTRODUCTION

The current meat consumption patterns and competition from other meats in addition to the current popularity of meat substitutes present a challenge to today's pork producer to provide an acceptable quality product with a high muscle to fat ratio. In order to accomplish this, it will be necessary to identify the superior muscular, trim carcasses. One of the best measures of carcass value is the total pounds of edible portion in the carcass. However, it does require a considerable amount of time and effort to break an entire carcass into its fat, bone and edible portion components.

At the present time the industry is using a variety of methods to evaluate pork carcasses. An accurate prediction equation to estimate the total pounds of edible pork in a carcass would appear to be a very useful tool in determining differences in carcass value.

This study was designed to (1) derive prediction equations to estimate total fat, bone and edible portion components of the pork carcass, (2) study the usefulness of additional fat thickness measurements as well as various fat probes for estimating carcass composition, and (3) study the correlation coefficients between various carcass measurements and total edible portion weight.

Several carcass weights and measurements were recorded, the simple correlation coefficients were calculated and then with the use of a stepwise multiple regression program the most valuable measurements were selected to be used in prediction equations to estimate the total fat, bone and edible portion components.

## REVIEW OF LITERATURE

Measurements of the thickness of the subcutaneous fat layer at various points on the surface have long been used as indicators of the general level of fatness of a carcass. The justification for this was first investigated by Hankins and Ellis (1934) as reported by Harrington (1958) who related the percentage of body fat in 60 pigs of varying weights with split-carcass backfat measurements. The average of five backfat measurements had a correlation of 0.84 with the percentage extracted fat. The thickness of backfat at the seventh dorsal vertebra alone explained 59% of the variation in the percentage of extractable fat (r = 0.77). Warner, Ellis and Howe (1934) also demonstrated that backfat thickness was related to carcass cutout.

Backfat thickness is an objective carcass measurement which is relatively easy to obtain. The recording of pork backfat measures originally started with five to eight measurements as reported by Aunan and Winters (1949), De Pape and Whatley (1956), Doornenbal, Wellington and Stouffer (1962), Hazel and Kline (1952) and Whiteman and Whatley (1953). At present the most popular method of reporting backfat thickness is to use an average of three measurements taken opposite the first rib, last rib and last lumbar vertebra perpendicular to the surface of the skin and including the skin thickness.

Aunan and Winters (1949) showed correlations of -.63, -.58 and 0.66 between average backfat thickness and the lean content of the carcass, percent primal cuts and dressing percent, respectively.

Zobrisky et al. (1954) indicated that there was a high correlation between backfat thickness and total yield of fat in the carcass. Nelson (1962) demonstrated that backfat thickness was a better predictor of lean cut weight than loin muscle mass, carcass length or longissimus dorsi area. Gnaedinger et al. (1963) reported a correlation coefficient of 0.69 between fat in the carcass and backfat thickness.

Stouffer and Burgkart (1965) showed a simple correlation of 0.76 between total fat in the carcass and backfat thickness. Kline (1951) reported a high positive correlation between average backfat thickness and the amount of fat in the pork carcass. Zobrisky et al. (1959) indicated that an accurate estimate of the amount of fat in a carcass can be determined from carcass backfat measurements. Zobrisky also reported that the yield of primal cuts was negatively correlated with backfat thickness measurements.

Henry, Bratzler and Luecke (1963) reported a -.62 correlation coefficient between average carcass backfat and lean cuts on a carcass basis. The highly significant correlations found by Henry and co-workers between average backfat thickness and percent fat in the shoulder, loin, belly and ham verify that average backfat thickness may be used to predict the fat yield of swine carcasses. Wiley, Pearlberg and Jones (1951) as reported by Topel (1968) showed that as average backfat thickness increased so did the weight and yield of fat cuts. Bowman, Whatley and Walters (1962) reported a high multiple correlation ($R = 0.70$) between percent separable lean and carcass backfat thickness and longissimus dorsi area at the tenth rib. Gee (1967) found a correlation coefficient of 0.84 between average backfat thickness and percent fat in the carcass.

Several researchers (Brown, Hillier and Whatley, 1951; Whiteman and Whatley, 1953; Carpenter and King, 1964; Pearson et al., 1956; Price, Pearson and Benne, 1957) working with backfat measurements did not show high correlations between carcass backfat measurements and carcass cutout information. Doornenbal et al. (1962) found that correlations between carcass fat measurements and total fat in the carcass and cuts were significant but low. In general these relationships were much higher in barrows than gilts.

McMeekan (1941) as reported by Harrington (1958) investigated the relation between total fat and backfat measurements and found the correlations to be very high. McMeekan found that the single measurement most closely related to total fatness, which cannot be measured on the normal split carcass, is the thickness of fat over the longissimus dorsi muscle on the surface revealed when the carcass is cut at the last rib. The measurement was taken at right angles to the skin 1 1/2 inches from the median line and this measurement alone accounted for 93% of the variation in total fat (r = 0.97).

The estimation of the muscle content or leanness of the slaughtered pig by means of carcass measurements is a more difficult problem than the estimation of fatness. Hammond (1933) as reported by Harrington (1958) stressed that accurate knowledge of the degree of muscling of a carcass can only be obtained by cutting the carcass, preferably in the region of the loin. Of the objective measures used to predict the amount of lean contained within a carcass, the *longissimus dorsi* area measurement is very common and receives wide use. Although most workers agree *longissimus dorsi* area is a worthwhile measurement, there is some controversy about the predictive value of different locations on the loin. However, Kline and Hazel (1955) and Kline and Goll (1964) point out that the correlations between most of the cross sectional areas (at different locations) and lean cut yields are about equal. According to Kline and Hazel (1955) there appears to be very little variation in area from side to side if the same anatomical locations are used for points of reference.

*Longissimus dorsi* area has been used alone and in combination with other measurements to predict lean carcass cutout values. Zobrisky *et al*. (1954) reported that after comparing several measures of leanness the cross sectional area of the *longissimus dorsi* showed the highest correlation with yield of lean in the carcass. Pearson *et al*. (1956), Kline and Goll (1964), Zobrisky *et al*. (1959), Kline and Hazel (1955), Holland and Hazel (1958) and Doornenbal, Wellington and Stouffer (1962) have indicated that *longissimus dorsi* area may predict from 30 to 50% of the variation in carcass lean cutout. Topel, Merkel and Mackintosh (1965) showed that *longissimus dorsi* area was nearly as accurate in predicting the lean cut yield of five different pork muscles as the *longissimus dorsi* weight. Batcher *et al*. (1962) reported that *longissimus dorsi* area is a good indicator of the lean content of the ham, shoulder and loin as well as the total percent lean in the carcass. Cahill, Sutton and Kunkle (1953) stated that the area of longissimus dorsi muscle was correlated with the weight of the primal cuts and with the primal cuts as a percentage of live weight.

Emerson *et al*. (1964), Varney *et al*. (1962), Wallace *et al*. (1959) and Mullins *et al*. (1960) showed results which indicated that the relationship of live weight to longissimus dorsi development is not linear. Their results indicated that heavier hogs had significantly less longissimus dorsi area when expressed as square inch per 100 pounds of carcass.

Some researchers question the accuracy of the longissimus dorsi tracing. Fredeen and Jarmaluk (1962) reported that the accuracy of a tracing was dependent upon the cut to be traced, the complexity of the musculature and the number of individuals responsible for the tracings and planimeter readings. Most research workers measure the area of the longissimus dorsi muscle tracing with a compensating polar planimeter.

Carcass length, a measurement easily taken and included in the meat hog certification program, is another objective measure used to evaluate the pork carcass. The importance of swine length has received much attention by pork producers who contend that length must be considered because it may be related to various production traits.

Robison, Kunkle and Cahill (1952) indicated that as length increased and as backfat thickness decreased the percentage of lean cuts increased and the percentage of fat trimmings decreased. Nelson (1962) reported that body length was associated with an increase in longissimus dorsi mass. Pearson, Bratzler and Magee (1958) showed that as length increased the percentage of loin also increased. Zobrisky et al. (1959) reported that partial correlation analysis indicated that carcass length was correlated with carcass width and backfat thickness.

At constant carcass weight the following workers as reported by Harrington found a negative correlation between carcass length and backfat thickness: Bennett and Coles (1946), Fredeen (1953), Harrington and Pomeroy (1955) and Johansson and Korkman (1950).

The following researchers have shown very little or no relationship between carcass length and carcass cutout yields of any kind: Bowman, Whatley and Walters (1962); Doornenbal et al. (1962); Henry, Bratzler and Luecke (1963); Holland and Hazel (1958); Pearson et al. (1956); Price, Pearson and Benne (1957) and Zobrisky et al. (1959). Gee (1967) reported a low negative correlation between carcass length and percent edible portion.

Another objective measure used to evaluate the pork carcass is the relative amount of various cuts and their components such as lean, fat and bone. A complete carcass breakdown is needed to obtain lean, fat and bone weights. Thus, it involves a considerable amount of time dividing the tissue into its component parts. Smith, Klay and Carnoham (1964) reported on a study involving physical separation of 20 pork carcasses each weighing approximately 140 pounds. They found the average component tissue values to be 9.0% bone, 4.5% skin, 43.3% fat and 43.0% lean for total carcass composition. Stouffer and Burgkart (1965) showed simple correlations among the following: total weight of lean in the carcass versus ham weight, 0.82; lean in the ham, 0.93; lean in the loin, 0.82 and lean in the shoulder, 0.72. They also obtained a correlation coefficient of 0.92 by associating longissimus dorsi area and percent lean cuts were the separable lean in the carcass. Bruner and Van Stavern (1961) reported that longissimus dorsi area and percent lean cuts were significantly correlated with the age group for gilts.

Wiley et al. (1951) found that as the average backfat thickness increased the percentage of lean cuts tended to decrease. Backfat thickness was the most important factor in determining the percentage of lean cuts. They also indicated that as carcass weight increased the percentage of lean cuts appeared to decrease. In addition, these workers noted a slight tendency within carcass groups for the percentage of lean cuts to increase as either the body length or leg length increased.

Several researchers have worked with various carcass measurements and values in an attempt to predict the lean content of the carcass. Osinska (1965), as reviewed by Topel (1968), reporting the predictive values of some carcass measurements for estimating carcass lean content indicated that the weight of the fat trim gave the most accurate prediction of carcass lean content.

Blendl (1966), as cited by Topel (1968), reporting on results from 305 German improved Landrace pigs found that both the correlation between carcass weight and the weight of the leg and the correlation between weight of the leg and the meat within the leg are highly significant. Blendl (1966), as reported by Topel (1968), from a second study showed results to indicate that the thinnest fat thickness measurement covering the longissimus dorsi area, as measured between the 13th and 14th rib, has a high negative correlation ($r = -.74$) with the total weight of lean in the carcass.

Pearson *et al.* (1956) investigated the fat-lean ratio in the cross section of the rough loin at the last rib as a possible measure of carcass leanness. Correlation coefficients of approximately -.60 between the fat-lean ratio and several measures of carcass cutout indicated the relationship may be high enough to be very useful.

Osinska and Kielanowski (1958) as reported by Topel (1968) calculated simple and partial correlations between the backfat thickness measurements at various points and the fat content in primal cuts and between the longissimus dorsi area measurements and the lean content in primal cuts. The measurement over the shoulder was found to be the least reliable, followed by the measurement over the middle of the back. The depth of the longissimus dorsi muscle was found to be more highly correlated with the hot carcass weight than with the lean content in primal cuts, and it was concluded that this measurement cannot be used as a measure of leanness when carcasses similar in weight are to be compared.

Fredeen et al. (1964) studied relationships between a number of split and internal carcass measurements and percent lean cut yield of the carcass and its component cuts. They found carcass length and weight to have a low predictive value, accounting respectively, for approximately 9 and 4% of the total variance in percent yield of the trimmed lean cuts (ham, loin, picnic and butt). The most useful predictors of percent yield of lean cuts and the proportion of total variance explained by each were percent yield of trimmed loin, 83%; ratio of longissimus dorsi area to total backfat, 53% and total backfat, 54%.

Lu et al. (1958) analyzed separation data from 121 hog carcasses in an attempt to find means of estimating the percentages of lean, fat and bone in the carcass. It was found that three measurements are needed for an estimation of the percentages of lean, fat and bone, namely, the fat depth of the last rib probe, the average backfat thickness and the carcass weight. The carcass fat percentage was estimated with a multiple correlation coefficient of 0.919 by the following equation: $X_1 = 25.1635 + .2353(X_2) + 9.6013(X_3) - .0387(X_4)$ where $X_1$ = carcass fat percent, $X_2$ = last rib fat probe, $X_3$ = average backfat thickness and $X_4$ = carcass weight.

Buck, Harrington and Johnson (1962 ) analyzed 250 pigs to study the value of carcass measurements in predicting the percentage lean in the carcass. For pigs of the same breed and sex these workers found that the best predictions of leanness possible without cutting the carcass were derived from measurements of shoulder and minimum loin backfat. Mid-backfat measurements improved the accuracy of prediction, but length and depth of carcass did not. However, measurements made after cutting the carcass and exposing the longissimus dorsi at the last rib gave more accurate predictions of percentage lean than did the split carcass measurements.

Reports have consistently shown that fat is the most variable component in the beef carcass as well as the pork carcass. As the percentage of fat increases there is an almost proportionate decrease in lean content. Subcutaneous fat measurements taken at numerous locations on the beef carcass have been investigated in an attempt to find specific measurements which are highly associated with carcass composition (Allen, 1966, as reported by Hedrick, 1968; Breidenstein, 1965, as reported by Hedrick, 1968; Lewis, Brungardt and Bray, 1964). These studies indicate that fat thickness measurements taken in the lumbar and thoracic area are more highly related to carcass composition than fat measurements from other areas of the carcass. Allen (1966) reported that the fat measurements most highly related to percent separable components and retail yield were single fat measurements over the 12th rib three-fourths of the distance from the medial to lateral edge of the longissimus dorsi muscle. Breidenstein (1965) indicated that individual subcutaneous fat measurements over the 12th rib were more valuable in predicting retail yield of steer carcasses than those taken in other locations. Breidenstein also indicated that fat measurements over the blade area of the chuck and rump area were valuable in evaluating carcasses. Lewis _et al_. (1964) observed that fat probe measurements over the rump and clod were more highly associated with percent trimmed retail cuts of heifer carcasses than a single fat measurement at the 12th rib surface.

Abraham _et al_. (1968) reported on a study of carcass characteristics involving 835 beef carcasses. They found that carcass weight accounted for most of the variation in weight of boneless steak and roast meat. Fat thickness was the most important variable in multiple regression equations for predicting percent of boneless steak and roast meat. The average of three fat thickness measurements taken at one-fourth, one-half and three-fourths the length of the _longissimus dorsi_ muscle from the chine bone end resulted in higher coefficients of multiple determination than a single fat thickness measurement taken three-fourths of the length of the _longissimus dorsi_ muscle from the chine bone. Area of _longissimus dorsi_ muscle was significantly related to yield of boneless steak and roast meat. Beef carcass length was not significantly related to yield of boneless steak and roast meat.

Henderson, Goll and Kline (1966) working with beef reported that the correlations between _longissimus dorsi_ area and total carcass lean were low. Calculating _longissimus dorsi_ area per 50 kg of carcass weight increased this relationship. The correlations between fat thickness and measures of carcass yield were very high.

Oliver et al. (1968) worked with data from 337 lamb carcasses to predict cutability of lamb carcasses from carcass weights and measures. They found that chilled carcass weight, body wall thickness and kidney fat weight had a coefficient of determination of ($R^2$) = 93.83 when predicting weight of consumer cuts. The addition of several other variables did not raise the predictive value.

Hoke et al. (1961) completed a detailed study concerning objective measures of lean cut yield in lamb carcasses. They reported that among the factors studied a combination of fat thickness, conformation grade and percent kidney fat accounted for 74, 85, 78, 53 and 78% of the variation in yields in the prime, choice, good, combined utility and cull grades and total sample, respectively.

Johnston et al. (1967) reported on studies concerning the estimation of yields of retail cuts from lamb carcasses. They used fat thickness probes on the intact carcass made at the shoulder and over the rump. They reported simple correlations of -.65, -.72 and -.69 between salable boneless cuts and the carcass probe at the shoulder, rump and rib area, respectively. Body length was found to have very little correlation ($r = -.05$) with total salable boneless cuts. The simple correlation between total salable boneless cuts and percent kidney knob was -.65. The data indicated that the simple correlation between total salable boneless cuts and a single measurement of fat thickness over the longissimus dorsi muscle explained approximately 44% of the variance in total salable boneless cuts. The addition of percentage kidney knob as a variable increased the explained variance in total salable boneless cuts to 59%. The addition of longissimus dorsi area to the above two variables explained approximately 65% of the variance in total salable boneless cuts. The addition of carcass weight to the above three variables did not increase the explained variance. In all of the multiple regression analyses, the inclusion of longissimus dorsi area increased the correlation coefficients.

## METHODS OF PROCEDURE

Data for this project were collected from a total of 150 pigs over a two-year period. The first portion of the data was collected at the South Dakota State University Meat Laboratory during the summer of 1967 from 75 spring farrowed pigs. The remaining portion of the data was collected during the summer of 1968 from 75 spring farrowed pigs. All 150 pigs were crossbred of predominant Hampshire-Yorkshire breeding. Each year the pigs consisted of 40 barrows and 35 gilts. The pigs were allotted shortly after weaning into groups consisting of 15 pigs per pen. All the pigs were self-fed a similar balanced ration and managed in the same manner. The desired slaughter weight of 200 pounds was based on a 24-hour shrink rather than an off-feed basis. When a pig reached the predetermined slaughter weight plus 10 pounds, it was removed from the feeding trial and transported to the holding facilities at the South Dakota State University Meat Laboratory. In the holding facilities the pigs were subjected to a 24-hour shrink with access to water but not feed.

Immediately before slaughter each pig was weighed to the nearest pound on the scale in the holding facility and this weight was recorded as the slaughter weight. Directly following the weighing, the pig was taken to the slaughter area, stunned, hung up and bled. After bleeding the pig was scalded in 143° F water and then the hair and toenails were removed. Following the hair removal, the head was removed at the atlas joint near the base of the skull leaving the jowls on the carcass. The tongue was removed from the head and the head was weighed to the nearest one-tenth pound.

The carcass was then opened down the ventral midline. The complete viscera was removed and weighed as a single unit to the nearest one-tenth pound. Next, the gall bladder was removed from the liver and the weight of the liver was recorded. The sternum was split and the complete pluck was removed and weighed. The carcass was then split into a right and left half with the use of a power saw. Following the splitting the leaf fat was removed from both the right and left side and weighed to the nearest one-tenth pound not including the weight of the kidneys. The last step of the slaughter procedure was to wash the carcass before it was put in the cooler.

The carcasses were chilled for at least 48 hours at a temperature of 36 to 38° F before carcass measurements were taken. Backfat measurements were taken on both sides of each carcass opposite the first rib, last rib and last lumbar vertebra. The average of the three measurements taken on both sides was recorded as actual backfat thickness. The carcass length measurement is also an average of the right and left side measured from the anterior edge of the first rib to the lower edge of the aitch bone.

While the carcass was in the cooler hanging on the rail, the wholesale loin section of the carcass was cut between the 10th-11th rib to expose the longissimus dorsi area. In order to measure the longissimus dorsi area more easily, the 9th-10th ribs were severed where they would normally be cut in the process of separating the wholesale loin from the belly. The area of the longissimus dorsi muscle from both the left and right side of each carcass was traced using acetate tracing paper. The longissimus dorsi area of each side of every carcass was then determined using a compensating polar planimeter. The average of both sides was recorded as actual longissimus dorsi area. In addition to measuring the longissimus dorsi area at this location, two fat thickness measurements were recorded. The first measurement was recorded at one-fourth the length of the longissimus dorsi muscle from the chine bone end and the second at one-half the length of the longissimus dorsi muscle from the chine bone end. Refer to figure 1 for exact location of measurements.

In addition to the carcass measurements described above, several fat probes were made on both the right and left sides of each carcass at various locations. Fat probes were made opposite the 4th cervical vertebra and 5th thoracic vertebra at distances of 3, 6 and 9 inches from the dorsal midline. Fat probes were taken opposite the 4th lumbar vertebra at distances of 4 and 6 inches from the midline. There were also three fat probes taken on the outside and two on the inside of the ham. Figures 2 and 3 show the locations of the fat probes.

Following at least 48 hours in the cooler, a chilled carcass weight for each side was obtained and recorded. Wholesale cuts were made according to the procedure as outlined in the Proceedings of the Fifth Annual Reciprocal Meat Conference by Cole (1952) and the

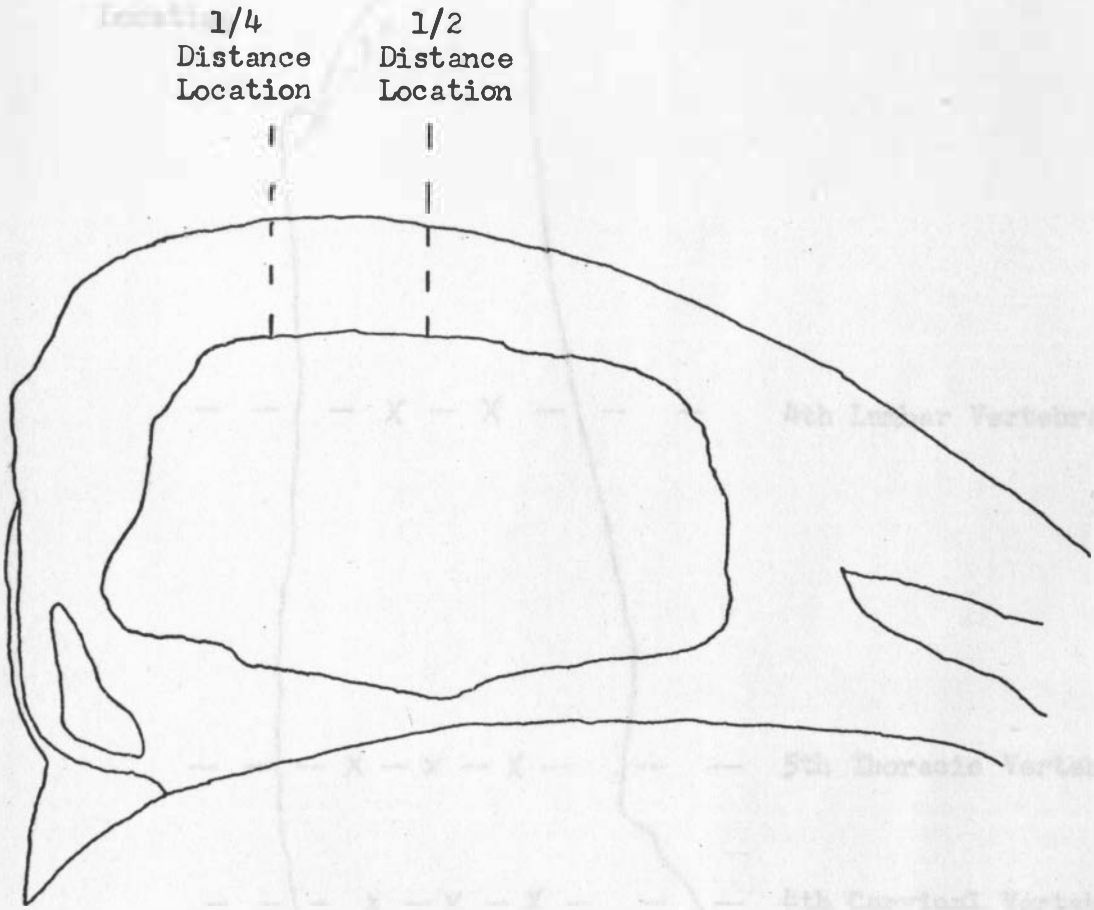


Figure 1. Fat thickness measurements over <u>longissimus dorsi</u> muscle.

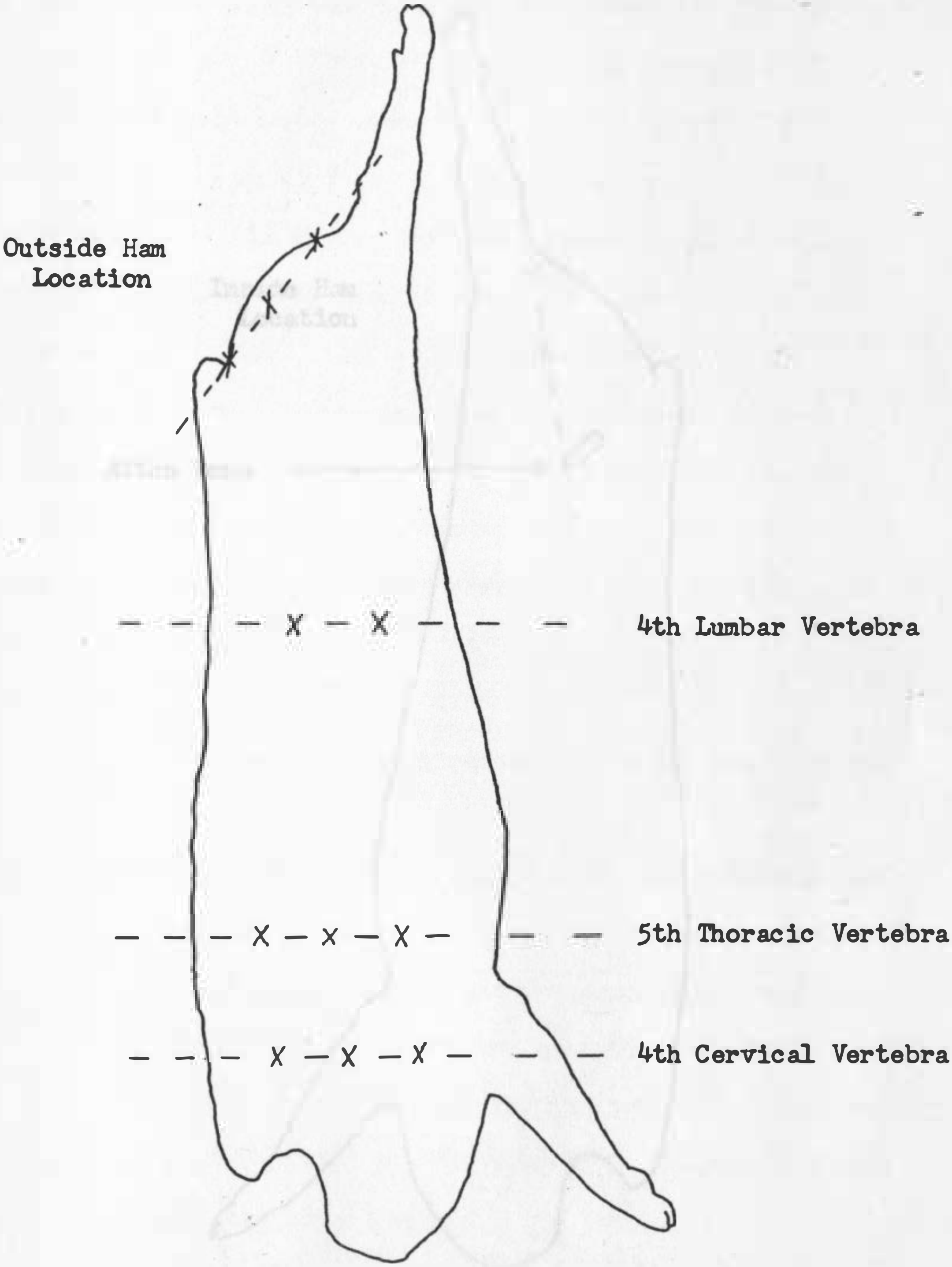


Figure 2. Fat probe locations.

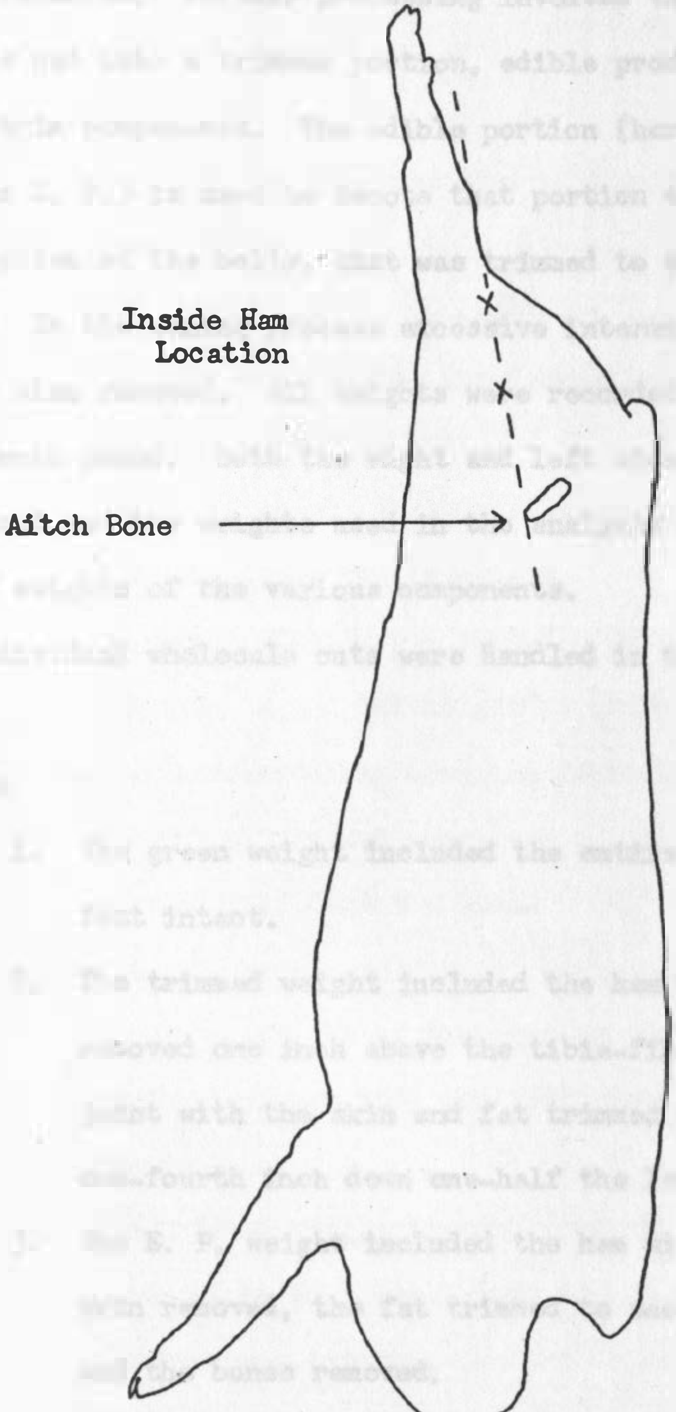


Figure 3. Fat probe locations.

weights were recorded. Further processing involved the separation of each wholesale cut into a trimmed portion, edible product portion, bone and fat trim components. The edible portion (here after referred to as E. P.) is used to denote that portion of the lean, with the exception of the belly, that was trimmed to one-fourth inch external fat. In the boning process excessive intermuscular fat deposits were also removed. All weights were recorded to the nearest one-tenth pound. Both the right and left sides of each carcass were cut and the weights used in the analysis of the data are the total weights of the various components.

The individual wholesale cuts were handled in the following manner:

A. Ham

1. The green weight included the entire ham with the foot intact.
2. The trimmed weight included the ham with the foot removed one inch above the tibia-fibula tarsal joint with the skin and fat trimmed uniformly to one-fourth inch down one-half the length of the ham.
3. The E. P. weight included the ham with the remaining skin removed, the fat trimmed to one-fourth inch and the bones removed.
4. The bone weight of the ham included part of the pelvic girdle, the femur, tibia-fibula and coccygeal vertebrae but did not include the foot weight.

5. The fat weight included both the fat and skin removed from the ham.

B. Loin

1. The green weight consisted of the intact wholesale loin.
2. The trimmed weight included the loin with the fat-back removed leaving one-fourth inch of fat uniformly over the loin.
3. The E. P. weight included the boneless loin roast, tenderloin and the lean trim.
4. The bone weight was composed of a small portion of the scapula and pelvic girdle in addition to the ribs and vertebrae normally found in the loin.
5. The fat weight was comprised of all the fat and skin removed from the loin.

C. Shoulder

1. The green weight of the shoulder included the shoulder proper with the foot, neck bones and jowl removed.
2. The trimmed weight was obtained after removing the clear plate down two-thirds of the length of the shoulder and trimming the fat to one-fourth inch.
3. The weight of the E. P. included the weight of the boned shoulder and all the lean trim from the shoulder.

4. The weight recorded as bone included the scapula, humerus, radius ulna but excluded the foot weight.
5. The fat weight included both the fat and skin weight from the shoulder.

D. Side

1. The green weight of the side did not include the weight of the spare ribs.
2. The trimmed weight was the weight recorded after removal of the teat line and additional squaring.
3. The squared belly as it would normally be used for bacon in addition to the lean trim from the portion that was removed in the squaring process was weighed and recorded as E. P.
4. The fat weight included the fat in addition to the skin from that portion of the side removed in the squaring process.

E. Bone Cuts

1. The green weight included the intact neck bones as well as the spare ribs.
2. The E. P. weight was the total lean trim from the spare ribs and neck bones.
3. The bone weight included the neck bones, ribs and sternum.

F. Jowl

1. The E. P. weight included all the lean after removal of the excessive fat.
2. The fat weight was made up of the fat and skin removed from the jowl.

All the data were recorded and placed on IBM cards for analysis. Simple correlation coefficients, multiple correlation coefficients (adjusted for degrees of freedom), partial regression coefficients as well as the coefficient of determination ($R^2$) were calculated. All 47 traits were run simultaneously in a stepwise multiple regression program. When the coefficients of determination ($R^2$) were greater than 50% and practical equations appeared feasible, the partial regression coefficient and the appropriate means were used to calculate the (a) values used in setting up prediction equations.

# RESULTS AND DISCUSSION

## Means and Standard Deviations

The means and standard deviations for the parameters used in this study are presented in table 1.

## Simple Correlations

Simple correlations were computed to evaluate the relative relationship and accuracy of certain carcass measurements as indicators of carcass value. The values used to determine carcass merit were the weight of primal cuts (ham, loin, shoulder and belly) and weight of lean cuts (ham, loin and shoulder), percent ham and loin of chilled carcass weight as well as the weight of total bone, fat and E. P. components of the carcass. All of the simple correlation coefficients involving the carcass measurements as related to carcass value are presented in table 2.

Animal age at slaughter was not significantly correlated with any of the measures of carcass value. However, it is interesting to note that the small correlation that did exist between animal age at slaughter and pounds of E. P. was negative.

Correlation coefficients between weight off test and weight of primal cuts, lean cuts, percent ham and loin, total bone, total fat and total E. P. weight were 0.35 ($P<.01$), 0.14, -.23 ($P<.05$), 0.16 ($P<.05$), 0.22 ($P<.01$) and 0.24 ($P<.01$), respectively.

Slaughter weight was found to have a highly significant negative correlation with percent ham and loin and had a significant positive ($P<.01$) correlation with total fat weight.

TABLE 1. MEANS AND STANDARD DEVIATIONS

| Variable | Mean | Standard deviation |
|---|---|---|
| Animal age at slaughter (days) | 160.80 | 11.02 |
| Weight off test (lb) | 211.00 | 3.99 |
| Slaughter wt (lb) | 203.17 | 5.08 |
| Head wt (lb) | 11.79 | 1.13 |
| Viscera wt (lb) | 16.61 | 1.89 |
| Liver wt (lb) | 2.94 | 0.30 |
| Pluck wt (lb) | 3.37 | 0.41 |
| Leaf fat wt (lb) | 3.48 | 0.69 |
| Carcass length (in) | 30.16 | 0.73 |
| Average carcass backfat (in) | 1.39 | 0.20 |
| <u>Longissimus dorsi</u> area (sq in) | 4.51 | 0.57 |
| Fat cover one-fourth length of L. D. muscle from chine bone end | 1.39 | 0.22 |
| Fat cover one-half length of L. D. muscle from chine bone end | 1.35 | 0.28 |
| Fat probe outside ham (4 in) | 0.34 | 0.10 |
| Fat probe outside ham (6 in) | 0.58 | 0.12 |
| Fat probe outside ham (8 in) | 0.64 | 0.09 |
| Fat probe inside ham (4 in) | 0.28 | 0.07 |
| Fat probe inside ham (6 in) | 0.38 | 0.07 |
| Fat probe 4th cervical vertebra (3 in) | 0.61 | 0.13 |
| Fat probe 4th cervical vertebra (6 in) | 0.52 | 0.12 |
| Fat probe 4th cervical vertebra (9 in) | 0.56 | 0.12 |
| Fat probe 5th thoracic vertebra (3 in) | 0.61 | 0.08 |
| Fat probe 5th thoracic vertebra (6 in) | 0.66 | 0.10 |
| Fat probe 5th thoracic vertebra (9 in) | 0.66 | 0.11 |
| Fat probe 4th lumbar vertebra (4 in) | 0.66 | 0.10 |
| Fat probe 4th lumbar vertebra (6 in) | 0.76 | 0.09 |
| Chilled carcass wt (lb) | 149.42 | 4.08 |
| Ham, green wt (lb) | 35.84 | 2.42 |
| Ham, trimmed wt (lb) | 28.52 | 1.99 |
| Ham, E. P. wt (lb) | 22.64 | 1.96 |
| Ham, bone wt (lb) | 3.78 | 0.62 |
| Ham, fat wt (lb) | 7.55 | 1.02 |
| Loin, green wt (lb) | 40.17 | 2.69 |
| Loin, trimmed wt (lb) | 25.91 | 1.79 |
| Loin, E. P. wt (lb) | 21.12 | 1.65 |

TABLE 1 CONTINUED

| Variable | Mean | Standard deviation |
|---|---|---|
| Loin, bone wt (lb) | 5.19 | 0.50 |
| Loin, fat wt (lb) | 14.00 | 2.69 |
| Shoulder, green wt (lb) | 31.78 | 1.51 |
| Shoulder, trimmed wt (lb) | 25.98 | 1.49 |
| Shoulder, E. P. wt (lb) | 21.02 | 1.40 |
| Shoulder, bone wt (lb) | 3.14 | 0.39 |
| Shoulder, fat wt (lb) | 6.11 | 1.32 |
| Side, green wt (lb) | 27.76 | 2.27 |
| Side, trimmed wt (lb) | 18.93 | 2.06 |
| Side, E. P. wt (lb) | 22.21 | 1.90 |
| Side, fat wt (lb) | 5.58 | 1.06 |
| Bone cuts, green wt (lb) | 7.96 | 0.68 |
| Bone cuts, E. P. wt (lb) | 3.42 | 0.64 |
| Bone cuts, bone wt (lb) | 4.57 | 0.65 |
| Jowl, green wt (lb) | 4.91 | 1.10 |
| Jowl, E. P. wt (lb) | 1.75 | 0.86 |
| Jowl, fat wt (lb) | 3.20 | 0.93 |
| Foot wt (lb) | 3.87 | 0.32 |
| Total green wt (lb) | 148.55 | 4.08 |
| Total trimmed wt (lb) | 99.27 | 4.36 |
| Total E. P. wt (lb) | 92.16 | 4.73 |
| Total bone wt (lb) | 16.64 | 1.31 |
| Total fat wt (lb) | 36.46 | 4.96 |
| Ham and loin trimmed wt (lb) | 54.42 | 3.28 |
| Ham and loin E. P. wt (lb) | 43.62 | 3.59 |
| Ham and loin fat wt (lb) | 21.55 | 3.30 |
| Primal cuts wt (lb) (Ham, loin, belly, shoulder) | 99.35 | 4.42 |
| Lean cuts wt (lb) (Ham, loin, shoulder) | 80.41 | 4.18 |
| Percent ham and loin of chilled carcass wt | 36.42 | 2.07 |

TABLE 2. CORRELATION COEFFICIENTS BETWEEN CARCASS MEASUREMENTS AND CARCASS CUTOUT VALUES

| Carcass measurements | Weight of primal cuts | Weight of lean cuts | Percent ham and loin | Total bone weight | Total fat weight | Total E. P. weight |
|---|---|---|---|---|---|---|
| Animal age at slaughter | -.06 | -.01 | 0.13 | 0.09 | 0.07 | -.15 |
| Weight off test | 0.35 | 0.14 | -.23 | 0.16 | 0.22 | 0.24 |
| Slaughter wt | 0.22 | 0.05 | -.26 | 0.05 | 0.27 | 0.21 |
| Head wt | 0.08 | 0.02 | -.00 | 0.01 | 0.06 | 0.03 |
| Viscera wt | 0.05 | 0.00 | -.06 | 0.15 | -.07 | 0.03 |
| Liver wt | -.17 | -.22 | -.16 | -.12 | 0.01 | -.03 |
| Pluck wt | 0.35 | 0.34 | 0.25 | 0.44 | -.28 | 0.35 |
| Leaf fat wt | -.38 | -.43 | -.48 | -.27 | 0.47 | -.42 |
| Carcass length | 0.17 | 0.23 | 0.27 | 0.34 | -.19 | 0.21 |
| Backfat | -.62 | -.68 | -.73 | -.58 | 0.83 | -.62 |
| <u>Longissimus</u> <u>dorsi</u> area | 0.54 | 0.62 | 0.61 | 0.41 | -.58 | 0.58 |
| Fat cover one-fourth length of L. D. muscle | -.50 | -.57 | -.69 | -.40 | 0.75 | -.56 |
| Fat cover one-half length of L. D. muscle | -.54 | -.60 | -.67 | -.42 | 0.72 | -.56 |
| Fat probe outside ham (4 in) | 0.00 | 0.01 | 0.03 | -.11 | -.17 | 0.09 |
| Fat probe outside ham (6 in) | -.04 | -.06 | -.21 | -.02 | 0.25 | -.07 |
| Fat probe outside ham (8 in) | -.29 | -.26 | -.29 | -.26 | 0.37 | -.30 |
| Fat probe inside ham (4 in) | 0.20 | 0.17 | 0.03 | 0.17 | -.21 | 0.30 |
| Fat probe inside ham (6 in) | 0.12 | 0.05 | -.10 | 0.11 | -.00 | 0.13 |
| Fat probe 4th cervical vertebra (3 in) | -.22 | -.22 | -.31 | -.24 | 0.37 | -.13 |
| Fat probe 4th cervical vertebra (6 in) | -.37 | -.38 | -.43 | -.42 | 0.53 | -.34 |
| Fat probe 4th cervical vertebra (9 in) | -.22 | -.22 | -.34 | -.42 | 0.36 | -.17 |

TABLE 2 CONTINUED

| Carcass measurements | Weight of primal cuts | Weight of lean cuts | Percent ham and loin | Total bone weight | Total fat weight | Total E. P. weight |
|---|---|---|---|---|---|---|
| Fat probe 5th thoracic vertebra (3 in) | -.31 | -.36 | -.40 | -.26 | 0.43 | -.25 |
| Fat probe 5th thoracic vertebra (6 in) | -.44 | -.49 | -.53 | -.38 | 0.53 | -.37 |
| Fat probe 5th thoracic vertebra (9 in) | -.31 | -.32 | -.42 | -.34 | 0.45 | -.24 |
| Fat probe 4th lumbar vertebra (4 in) | -.49 | -.50 | -.50 | -.38 | 0.54 | -.43 |
| Fat probe 4th lumbar vertebra (6 in) | -.49 | -.56 | -.63 | -.40 | 0.64 | -.48 |
| Chilled carcass wt | 0.56 | 0.44 | -.09 | 0.35 | 0.16 | 0.54 |

Correlation of 0.16, $P<.05$; 0.21, $P<.01$.

The pigs on this study were all slaughtered within a very narrow weight range and thus the correlations of total fat and E. P. with slaughter weight may not be as large as if the pigs had been slaughtered at a wider weight range.

The correlations between head weight and viscera weight and any measure of carcass value were extremely low. However, it is difficult to explain why liver weight was significantly negatively correlated with weight of primal cuts, weight of lean cuts and percent ham and loin. Pluck weight had significant correlations of 0.35, 0.34, 0.25, 0.44, -.28 and 0.35 with weight of primal cuts, weight of lean cuts, percent ham and loin, total bone weight, total fat weight and total E. P. weight, respectively. It is logical to assume that as the pig increased in weight his pluck weight would increase as well as the weight of various components of the carcass, but it is difficult to explain the negative relationship between pluck weight and total fat weight.

The amount of kidney and pelvic fat in both the beef and lamb carcasses appears to be useful in determining the value of a carcass because both the lamb and beef U.S.D.A. yield grades use the estimated kidney fat percent in determining the yield of the carcass. Likewise, the weight of the leaf fat from the pork carcass does have a high positive relationship ($r = 0.47$) with total fat weight of the carcass. Leaf fat weight was also found to have a highly significant negative correlation with all the reported measures of carcass value.

Carcass length as reported in the review of literature does show some relationship to carcass cutout values according to some scientists. However, other researchers report little or no correlation between carcass length and carcass cutout values. This study did show significant relationships between carcass length measured in inches and weight of primal and lean cuts, percent ham and loin, total bone weight and total E. P. weight. There was also a significant negative correlation between length and total fat weight. However, close examination of table 2 will indicate that these reported correlations are rather low (0.17 to 0.34). As indicated in the literature, Bowman, Whatley and Walters (1962), Doornenbal _et al_. (1962), Henry, Bratzler and Luecke (1963), Holland and Hazel (1958), Pearson _et al_. (1956), Price, Pearson and Benne (1957) and Zobrisky _et al_. (1959) found very little relationship between carcass length and carcass cutout yields of any kind.

Average carcass backfat thickness had a very high correlation (0.83) with total weight of fat in the carcass. This is in agreement with Zobrisky _et al_. (1954) who reported a high correlation between backfat thickness and total yield of fat in the carcass. Gnaedinger _et al_. (1963) working with 24 pigs in the 181 to 220 pound range reported a correlation coefficient of 0.69 between fat in the carcass and backfat thickness. Kline (1951) and Zobrisky _et al_. (1959) indicated that there was a high positive correlation between average backfat thickness and the amount of fat in the pork carcass. In a study involving 20 market weight hogs Stouffer and Burgkart (1965) reported a simple correlation of 0.76 between total fat in the carcass and backfat thickness. McMeekan (1941) also investigated the relation between total fat and backfat measurements and found the correlations to be very high.

Backfat thickness was also found to have highly significant negative correlations of -.62, -.68, -.73, -.58 and -.62 with weight of primal cuts, weight of lean cuts, percent ham and loin and total weight of bone and E. P., respectively. These correlations are in close agreement with the work of other researchers. Aunan and Winters (1949) showed correlations of -.63 and -.58 between average backfat thickness and the lean content of the carcass as well as percent primal cuts. Henry, Bratzler and Luecke (1963) reported a -.62 correlation coefficient between average carcass backfat and lean cuts on a carcass basis.

In the literature some researchers have reported a high relationship between the area of the longissimus dorsi muscle and various measures of carcass cutout value. Other scientists in recent years have shown these correlations to be somewhat less than the correlations reported in the earlier work. As can be seen from table 2, longissimus dorsi area in this study had a highly significant negative correlation with total fat weight (r = -.58). This study indicated that longissimus dorsi area has a highly significant relationship with various measures of carcass value. The correlation coefficients between longissimus dorsi area and measures of carcass cutout were weight of primal cuts, 0.54; weight of lean cuts, 0.62;

percent ham and loin, 0.61 and total E. P. weight, 0.58. This is in close agreement with Cahill, Sutton and Kunkle (1953) who reported that the area of the longissimus dorsi muscle was highly correlated with the weight of primal cuts. Batcher et al. (1962) reported that longissimus dorsi area was a good indicator of the total lean content of the carcass. Zobrisky et al. (1954) showed after comparing several measures that cross sectional area of the longissimus dorsi muscle gave a higher correlation with the yield of lean in the carcass than any other measure. The results of this study are in close agreement with most earlier work that reported a high correlation between various measures of carcass value and average carcass backfat as well as longissimus dorsi area.

The fat thickness measurements taken between the 10th and 11th ribs at locations of one-fourth and one-half the length of the longissimus dorsi muscle from the chine bone end showed highly significant correlations with carcass cutout values. These fat thickness measurements had nearly as high a relationship with total fat in the carcass as did average carcass backfat. Likewise, the negative relationship between fat thickness over the longissimus dorsi area and total pounds of E. P. was nearly as high as the correlation between average carcass backfat and total E. P. weight. Based on the high correlations with measures of carcass value, these fat thickness measurements would appear to be of value in estimating total fat or lean in the carcass. These results are similar to the results of Breidenstein (1965) who reported that individual subcutaneous fat measurements over the 12th rib were valuable in predicting retail yield of steer carcasses.

As indicated in the Methods of Procedure, a number of fat thickness probes were made on the carcass. Of the fat probe measurements taken on the outside of the ham, the probe at the 8-inch location had the highest correlation with carcass cutout values. However, these relationships were all quite low and thus would appear to be of very little value for predicting cutout yield. Likewise, the fat probe measurements made on the inside of the ham had very low correlations with measures of carcass value.

In general the fat probes made in the thoracic region showed much higher correlations with total fat content of the carcass than did the probes in the ham region or those at the locations of cervical vertebrae. The correlations between total fat weight and the fat probes at the 5th thoracic vertebra 3, 6 and 9 inches from the midline were 0.43, 0.53 and 0.45, respectively. All locations at the 5th thoracic vertebra did show highly significant negative correlations with carcass cutout values. The fat probes in the lumbar region were also highly significantly related to carcass cutout. The values ranged from the lowest negative correlation of -.43 between the fat probe at the 4th lumbar vertebra at the 4-inch location and total E. P. to the highest negative correlation of -.63 between the fat probe at the 4th lumbar vertebra at the 6-inch location and precent ham and loin.

In general, table 2 shows that the fat probes in the thoracic and lumbar regions had considerably higher correlations with measures of carcass value than did the fat probes in the ham or cervical vertebrae region. This appears to be in very close agreement with the beef carcass work of Allen (1966), Breidenstein (1965) and Lewis _et al._ (1964) who reported that their studies indicated fat thickness measurements taken in the lumbar and thoracic area were more highly related to carcass composition than fat measurements taken from other areas of the carcass.

The correlations between chilled carcass weight and weight of primal cuts, lean cuts, percent ham and loin, total bone weight and total E. P. weight were highly significant. The correlation between chilled carcass weight and total fat weight in the carcass was just significant ($P<.05$).

Table 3 shows correlation coefficients between some common carcass measurements. Correlation coefficients between animal age at slaughter and weight off test, leaf fat weight, carcass length, _longissimus dorsi_ area and fat cover one-half the length of _longissimus dorsi_ muscle were -.20, 0.17, 0.15, 0.28 and 0.15, respectively. Weight off test was highly correlated with slaughter weight and chilled carcass weight. Likewise, slaughter weight was highly related to chilled carcass weight.

Leaf fat weight showed a significant negative correlation with carcass length which indicates that as leaf fat weight increases carcass length decreases. The correlation between leaf fat weight and

TABLE 3. CORRELATION COEFFICIENTS BETWEEN SOME COMMON CARCASS MEASUREMENTS

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Animal age at slaughter | 1.00 | -.20 | -.09 | 0.17 | 0.15 | 0.03 | 0.28 | -.06 | -.15 | -.09 |
| 2. Weight off test | | 1.00 | 0.70 | 0.00 | 0.20 | 0.13 | 0.04 | 0.14 | 0.12 | 0.62 |
| 3. Slaughter wt | | | 1.00 | 0.08 | 0.23 | 0.23 | 0.01 | 0.15 | 0.17 | 0.53 |
| 4. Leaf fat wt | | | | 1.00 | -.26 | 0.34 | -.32 | 0.47 | 0.51 | -.04 |
| 5. Carcass length | | | | | 1.00 | -.20 | 0.15 | 0.33 | 0.23 | 0.10 |
| 6. Backfat | | | | | | 1.00 | -.52 | 0.75 | 0.71 | 0.04 |
| 7. <u>Longissimus dorsi</u> area | | | | | | | 1.00 | -.59 | -.58 | 0.14 |
| 8. Fat cover one-fourth length of L.D. muscle | | | | | | | | 1.00 | 0.86 | 0.08 |
| 9. Fat cover one-half length of L.D. muscle | | | | | | | | | 1.00 | 0.03 |
| 10. Chilled carcass wt | | | | | | | | | | 1.00 |

Correlation of 0.16, $P<.05$; 0.21, $P<.01$.

average carcass backfat was significant ($P < .01$) but had a rather low relationship ($r = 0.34$). The negative correlation between leaf fat weight and longissimus dorsi area was $-.32$. This study found high correlations between the fat cover measurements over the longissimus dorsi area and the leaf fat weight ($r = 0.47$ and $0.51$).

The relationships between carcass length and the carcass measurements listed in table 3 were all very low.

Backfat thickness was found to have a highly significant negative correlation with area of longissimus dorsi muscle ($r = -.52$). This work is in close agreement with Bowman, Whatley and Walters (1962) who reported a high negative correlation between carcass backfat thickness and longissimus dorsi area measured at the 10th rib. Average carcass backfat was highly significantly correlated with the fat thickness measurements taken over the longissimus dorsi area. McMeekan (1941) found that the single measurement most closely related to total fatness was the thickness of fat over the longissimus dorsi muscle on the surface revealed when the carcass was cut at the last rib.

Longissimus dorsi area was found to have highly significant negative correlations with the fat measurements taken over the longissimus dorsi area at the 10th and 11th rib ($r = 0.59$ and $-.58$). The fat thickness measurements taken at one-fourth and one-half the length of the longissimus dorsi muscle from the chine bone are very highly related ($r = 0.86$).

Table 4 reports the correlation coefficients between certain measures of carcass value. The weight of primal cuts was highly significantly correlated with weight of lean cuts (r = 0.88), percent ham and loin (r = 0.59), total bone weight (r = 0.60), total fat weight (r = 0.55) and total E. P. weight (r = 0.84). Weight of lean cuts was also highly correlated with percent ham and loin and total weight of bone, fat and E. P.

Percent ham and loin was found to be highly related with total bone, fat and E. P. weight with correlations of 0.54, 0.75 and 0.55, respectively. Total bone weight showed a significant correlation with both total fat and E. P. weight. The total fat weight was found to have a high correlation of 0.69 with total pounds of E. P.

TABLE 4. CORRELATION COEFFICIENTS BETWEEN CERTAIN MEASURES OF CARCASS VALUE

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1. Wt of primal cuts | 1.00 | 0.88 | 0.59 | 0.60 | -.55 | 0.84 |
| 2. Wt of lean cuts | | 1.00 | 0.80 | 0.66 | -.63 | 0.81 |
| 3. Percent ham and loin | | | 1.00 | 0.54 | -.75 | 0.55 |
| 4. Total bone wt | | | | 1.00 | -.50 | 0.51 |
| 5. Total fat wt | | | | | 1.00 | -.69 |
| 6. Total E. P. wt | | | | | | 1.00 |

Correlation of 0.16, $P < .05$; 0.21, $P < .01$.

Predictive Value of the Carcass Measurements

The primary objective of this project was to evaluate the predictive value of various carcass measurements. Partial regression coefficients for each variable used for prediction as well as coefficients of determination ($R^2$) and the multiple correlation coefficients are presented in the tables that follow. Tables 5 through 10 report the partial regression coefficients, coefficients of determination and multiple correlations for all of the 27 measurements used in predicting pounds of primal and lean cuts, percent ham and loin (chilled carcass weight) and total bone, fat and E. P. weight. The 27 measurements used were those which were collected before the carcass was processed and thus would be very practical to use to predict carcass value without requiring the labor necessary to process the carcass into its fat, bone and E. P. components. Tables 11 through 15 use five very easy to obtain measurements to predict weight of primal cuts, weight of lean cuts, total bone weight, total fat weight and total E. P. weight. Table 16 uses four commonly collected measurements to predict total pounds of E. P. Prediction equations which were derived are also presented and discussed.

The partial regression coefficients for each trait used in predicting pounds of primal cuts are presented in table 5. Using all 27 of the measurements collected before processing the carcass accounted for 80.8% of the variation in pounds of primal cuts. With the use of only 7 measurements, 79.2% of the variation was accounted for. Average carcass backfat alone accounted for 38.6% of the

TABLE 5. PARTIAL REGRESSION COEFFICIENTS FOR EACH TRAIT USED IN PREDICTING POUNDS OF PRIMAL CUTS

| Traits | Equations | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Average carcass backfat | -.85 | -.92 | -1.08 | -1.12 | -1.10 | -1.24 | -1.35 | -1.30 |
| Chilled carcass wt | 0.47 | 0.49 | 0.49 | 0.49 | 0.58 | 0.60 | 0.61 | |
| Leaf fat wt | -.70 | -.77 | -.73 | -.81 | -.83 | -.95 | | |
| Longissimus dorsi area | 0.83 | 1.06 | 1.10 | 1.12 | 1.01 | | | |
| Weight off test | 0.10 | 0.13 | 0.15 | 0.14 | | | | |
| Fat probe outside ham (8 in) | -3.11 | -4.67 | -4.61 | | | | | |
| Fat probe 4th lumbar vertebra (4 in) | -3.59 | -4.58 | | | | | | |
| Head wt | 0.15 | | | | | | | |
| Fat probe 5th thoracic vertebra (6 in) | -1.27 | | | | | | | |
| Liver wt | -.83 | | | | | | | |
| Animal age at slaughter | -.02 | | | | | | | |
| Fat cover one-half length of L. D. muscle | -2.05 | | | | | | | |
| Fat cover one-fourth length of L. D. muscle | 1.78 | | | | | | | |
| Slaughter wt | 0.06 | | | | | | | |
| Fat probe outside ham (4 in) | 1.90 | | | | | | | |
| Fat probe inside ham (6 in) | -1.40 | | | | | | | |
| Fat probe 5th thoracic vertebra (3 in) | -1.28 | | | | | | | |
| Fat probe 4th lumbar vertebra (6 in) | -1.33 | | | | | | | |
| Pluck wt | 0.21 | | | | | | | |
| Carcass length | -.14 | | | | | | | |
| Viscera wt | -.04 | | | | | | | |
| Fat probe 5th thoracic vertebra (9 in) | -.60 | | | | | | | |
| Fat probe 4th cervical vertebra (3 in) | -.42 | | | | | | | |

TABLE 5 CONTINUED

| Traits | Equations 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Fat probe outside ham (6 in) | -.17 | | | | | | | |
| Fat probe inside ham (4 in) | -.22 | | | | | | | |
| Fat probe 4th cervical vertebra (6 in) | 0.13 | | | | | | | |
| Fat probe 4th cervical vertebra (9 in) | -.10 | | | | | | | |
| Multiple correlation coefficient (R) | .899 | .890 | .886 | .881 | .875 | .868 | .855 | .621 |
| Coefficient of determination ($R^2$) | 80.8 | 79.2 | 78.5 | 77.6 | 76.6 | 75.3 | 73.1 | 38.6 |

variation in pounds of primal cuts. By adding chilled carcass weight to the average carcass backfat measurements, the explained variance increased to 73.1%. Equations 5 and 6 appear to be the most useful as prediction equations. Equation 6 utilizes average carcass backfat, chilled carcass weight and leaf fat weight. Equation 5 involves the same three measurements in addition to *longissimus dorsi* area. The addition of *longissimus dorsi* area only increased the coefficient of determination from 75.3% to 76.6%. The two equations for predicting pounds of primal cuts are as follows:

Equation 5: Y = 12.55 - 1.10 (average carcass backfat) + 0.58 (chilled carcass weight) -.83 (leaf fat weight) + 1.01 (*longissimus dorsi* area).

Equation 6: Y = 14.74 - 1.24 (average carcass backfat) + 0.60 (chilled carcass weight) -.95 (leaf fat weight).

Weight of the lean cuts is a commonly used indicator of carcass value. The results of the attempt to predict pounds of lean cuts are shown in table 6. Average carcass backfat was the measurement which accounted for most of the variation in pounds of lean cuts (46.1%). The addition of chilled carcass weight increased the explained variance to 68.1%. All 27 measurements used to predict pounds of lean cuts showed a multiple correlation coefficient of .893 and a coefficient of determination of 79.7. Equations 4 and 5 appeared most useful for predicting pounds of lean cuts and they are as follows:

TABLE 6. PARTIAL REGRESSION COEFFICIENTS FOR EACH TRAIT USED IN PREDICTING POUNDS OF LEAN CUTS

| Traits | Equations 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Average carcass backfat | -.78 | -.89 | -.89 | -1.08 | -1.16 | -1.45 | -1.41 |
| Chilled carcass wt | 0.48 | 0.43 | 0.44 | 0.43 | 0.43 | 0.48 | |
| Longissimus dorsi area | 1.55 | 1.43 | 1.53 | 1.75 | 1.97 | | |
| Leaf fat wt | -.62 | -1.11 | -1.02 | -.96 | | | |
| Fat probe 4th lumbar vertebra (6 in) | -5.25 | -6.25 | -6.55 | | | | |
| Liver wt | -1.51 | -1.15 | | | | | |
| Fat probe inside ham (6 in) | -5.17 | | | | | | |
| Animal age at slaughter | -.04 | | | | | | |
| Pluck wt | 0.81 | | | | | | |
| Fat probe 4th cervical vertebra (9 in) | 1.94 | | | | | | |
| Weight off test | -.09 | | | | | | |
| Carcass length | 0.54 | | | | | | |
| Fat probe 5th thoracic vertebra (3 in) | -3.91 | | | | | | |
| Fat cover one-half length of L. D. muscle | -1.84 | | | | | | |
| Fat probe 4th cervical vertebra (3 in) | 2.10 | | | | | | |
| Fat cover one-fourth length of L. D. muscle | 1.60 | | | | | | |
| Fat probe outside ham (4 in) | 1.58 | | | | | | |
| Fat probe 4th lumbar vertebra (4 in) | -1.88 | | | | | | |
| Fat probe inside ham (4 in) | -2.02 | | | | | | |
| Slaughter wt | -.03 | | | | | | |
| Head wt | 0.11 | | | | | | |
| Viscera wt | 0.03 | | | | | | |

TABLE 6 CONTINUED

| Traits | Equations 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Fat probe 4th cervical vertebra (6 in) | -.72 | | | | | | |
| Fat probe 5th thoracic vertebra (9 in) | 0.49 | | | | | | |
| Fat probe outside ham (8 in) | 0.25 | | | | | | |
| Fat probe outside ham (6 in) | 0.09 | | | | | | |
| Fat probe 5th thoracic vertebra (6 in) | 0.13 | | | | | | |
| Multiple correlation coefficient (R) | .893 | .876 | .873 | .867 | .854 | .825 | .679 |
| Coefficient of determination ($R^2$) | 79.7 | 76.7 | 76.2 | 75.2 | 72.9 | 68.1 | 46.1 |

Equation 4: Y = 13.11 - 1.08 (average carcass backfat) + 0.43 (chilled carcass weight) + 1.75 (*longissimus dorsi* area) -.96 (leaf fat weight).

Equation 5: Y = 8.89 - 1.16 (average carcass backfat) + 0.43 (chilled carcass weight) + 1.97 (*longissimus dorsi* area).

Both of these equations are relatively simple and have acceptable accuracy. Equation 4 accounted for 75.2% of the variation and equation 5 accounted for 72.9% of the variation in pounds of lean cuts. These results agree with Fredeen *et al.* (1964) who indicated that carcass backfat was a most useful predictor of yield of lean cuts because backfat alone did account for 54% of the variance in lean cut yield.

Ham and loin percent is probably the most commonly used indicator of carcass value. Therefore, prediction of this trait from carcass measurements would seem to have potential usefulness for measuring carcass meatiness. The results of the attempt to predict the ham and loin percent are shown in table 7. The amount of variation accounted for varied from 53.4% for average carcass backfat alone to a high of 72.9% when all 27 measurements were used. The same general pattern was true for predicting percent ham and loin as was true for predicting pounds of primal and lean cuts in that the fat probes taken on the outside of the carcass appeared to be of little predictive value. The combination of average carcass backfat and *longissimus dorsi* area had a multiple correlation coefficient of .781 and did account for 61.0% of the variation in percent ham and loin.

TABLE 7. PARTIAL REGRESSION COEFFICIENTS FOR EACH TRAIT USED IN PREDICTING PERCENT HAM AND LOIN

| Traits | Equations 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Average carcass backfat | -.29 | -.35 | -.39 | -.50 | -.53 | -.58 | -.75 |
| Longissimus dorsi area | 0.86 | 0.90 | 0.93 | 1.05 | 1.03 | 1.18 | |
| Leaf fat wt | -.52 | -.62 | -.70 | -.66 | -.64 | | |
| Weight off test | -.06 | -.09 | -.07 | -.08 | | | |
| Fat probe 4th lumbar vertebra (6 in) | -4.07 | -4.38 | -3.81 | | | | |
| Carcass length | 0.41 | 0.38 | | | | | |
| Fat probe inside ham (6 in) | -1.83 | | | | | | |
| Liver wt | -.65 | | | | | | |
| Pluck wt | 0.41 | | | | | | |
| Fat probe 4th cervical vertebra (3 in) | 1.83 | | | | | | |
| Fat probe inside ham (4 in) | -2.28 | | | | | | |
| Slaughter wt | -.03 | | | | | | |
| Fat probe outside ham (4 in) | 0.88 | | | | | | |
| Fat probe 4th cervical vertebra (6 in) | -.69 | | | | | | |
| Fat cover one-fourth length of L. D. muscle | -.36 | | | | | | |
| Chilled carcass wt | -.02 | | | | | | |
| Fat probe outside ham (8 in) | -.67 | | | | | | |
| Fat probe 4th cervical vertebra (9 in) | -.57 | | | | | | |
| Animal age at slaughter | -.01 | | | | | | |
| Fat probe 5th thoracic vertebra (6 in) | -.89 | | | | | | |
| Head wt | 0.03 | | | | | | |
| Fat cover one-half length of L. D. muscle | -.18 | | | | | | |

TABLE 7 CONTINUED

| Traits | Equations 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Fat probe 5th thoracic vertebra (9 in) | 0.25 | | | | | | |
| Viscera wt | 0.01 | | | | | | |
| Fat probe 4th lumbar vertebra (4 in) | -.15 | | | | | | |
| Fat probe 5th thoracic vertebra (3 in) | 0.09 | | | | | | |
| Fat probe outside ham (6 in) | 0.02 | | | | | | |
| Multiple correlation coefficient (R) | .854 | .837 | .827 | .819 | .805 | .781 | .731 |
| Coefficient of determination ($R^2$) | 72.9 | 70.1 | 68.4 | 67.1 | 64.8 | 61.0 | 53.4 |

The addition of leaf fat weight only increased the explained variance from 61.0% to 64.8%. Adding the weight off test to the above three variables increased the explained variance by 2.3%. The two equations which appeared the most practical for predicting percent ham and loin are as follows:

Equation 4: Y = 51.56 -.50 (average carcass backfat) + 1.05 (*longissimus dorsi* area) -.66 (leaf fat weight) -.08 (weight off test).

Equation 5: Y = 34.74 -.53 (average carcass backfat) + 1.03 (*longissimus dorsi* area) -.64 (leaf fat weight).

The accuracy of both equations is somewhat less than the accuracy of the equations reported to predict pounds of primal and lean cuts. Carcass length, slaughter weight, chilled carcass weight as well as animal age at slaughter appeared to be of little value in predicting percent ham and loin.

Table 8 contains the partial regression coefficients for each trait used in predicting total bone weight. The coefficients of determination for predicting bone weight are considerably lower than any other trait predicted, ranging from 33.6% for average carcass backfat alone to 65.0% for all 27 measurements. The addition of chilled carcass weight and the fat probe measurement at the 4th cervical vertebra to average carcass backfat only increased the explained variance to 52.0%. Because of the low coefficients of determination, prediction equations were not calculated.

Table 9 contains the partial regression coefficients for each trait used in predicting total fat weight. Seven equations are

TABLE 8. PARTIAL REGRESSION COEFFICIENTS FOR EACH TRAIT USED IN PREDICTING TOTAL BONE WEIGHT

| Traits | Equations 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Average carcass backfat | -.19 | -.25 | -.27 | -.29 | -.32 | -.39 | -.38 |
| Chilled carcass wt | 0.09 | 0.11 | 0.11 | 0.11 | 0.13 | 0.12 | |
| Fat probe 4th cervical vertebra (9 in) | -2.24 | -2.16 | -2.13 | -2.32 | -2.50 | | |
| Pluck wt | 0.51 | 0.52 | 0.56 | 0.62 | | | |
| Carcass length | 0.45 | 0.31 | 0.27 | | | | |
| Fat probe outside ham (8 in) | -2.06 | -1.76 | | | | | |
| Viscera wt | 0.14 | | | | | | |
| Liver wt | -.42 | | | | | | |
| Longissimus dorsi area | 0.32 | | | | | | |
| Fat probe outside ham (6 in) | 1.20 | | | | | | |
| Fat probe outside ham (4 in) | -1.26 | | | | | | |
| Fat probe 5th thoracic vertebra (9 in) | -.78 | | | | | | |
| Weight off test | -.02 | | | | | | |
| Fat cover one-fourth length of L. D. muscle | 0.78 | | | | | | |
| Fat cover one-half length of L. D. muscle | -.44 | | | | | | |
| Fat probe inside ham (4 in) | 0.87 | | | | | | |
| Fat probe 4th lumbar vertebra (6 in) | 0.43 | | | | | | |
| Fat probe 4th cervical vertebra (3 in) | 0.40 | | | | | | |
| Animal age at slaughter | 0.00 | | | | | | |
| Slaughter wt | 0.01 | | | | | | |
| Head wt | 0.03 | | | | | | |
| Fat probe 5th thoracic vertebra (3 in) | 0.37 | | | | | | |

TABLE 8 CONTINUED

| Traits | Equations 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Fat probe 4th cervical vertebra (6 in) | -.24 | | | | | | |
| Fat probe 4th lumbar vertebra (6 in) | 0.20 | | | | | | |
| Leaf fat wt | -.02 | | | | | | |
| Fat probe 5th thoracic vertebra (6 in) | -.13 | | | | | | |
| Fat probe inside ham (6 in) | 0.07 | | | | | | |
| Multiple correlation coefficient (R) | .806 | .766 | .758 | .743 | .721 | .691 | .580 |
| Coefficient of determination ($R^2$) | 65.0 | 58.7 | 57.5 | 55.2 | 52.0 | 49.7 | 33.6 |

TABLE 9. PARTIAL REGRESSION COEFFICIENTS FOR EACH TRAIT USED IN PREDICTING TOTAL FAT WEIGHT

| Traits | Equations | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Average carcass backfat | 1.08 | 1.51 | 1.57 | 1.61 | 1.68 | 1.88 | 2.05 |
| Leaf fat wt | 0.62 | 0.93 | 1.03 | 1.32 | 1.29 | 1.47 | |
| *Longissimus dorsi* area | -1.83 | -2.36 | -2.41 | -1.81 | -1.47 | | |
| Chilled carcass wt | 0.23 | 0.24 | 0.24 | 0.21 | | | |
| Animal age at slaughter | 0.09 | 0.07 | 0.07 | | | | |
| Fat probe outside ham (8 in) | 4.87 | 6.45 | | | | | |
| Pluck wt | -1.14 | | | | | | |
| Fat probe outside ham (4 in) | -6.19 | | | | | | |
| Fat cover one-half length of L. D. muscle | 3.23 | | | | | | |
| Carcass length | -.74 | | | | | | |
| Fat probe 4th lumbar vertebra (6 in) | 7.07 | | | | | | |
| Weight off test | 0.09 | | | | | | |
| Fat probe inside ham (4 in) | -3.16 | | | | | | |
| Head wt | 0.31 | | | | | | |
| Fat probe 4th lumbar vertebra (4 in) | -3.78 | | | | | | |
| Fat probe 4th cervical vertebra (6 in) | 2.85 | | | | | | |
| Fat probe 4th cervical vertebra (3 in) | -1.94 | | | | | | |
| Fat probe 5th thoracic vertebra (9 in) | 2.14 | | | | | | |
| Fat probe inside ham (6 in) | -2.22 | | | | | | |
| Slaughter wt | -.03 | | | | | | |
| Fat cover one-fourth length of L. D. muscle | -1.23 | | | | | | |
| Fat probe outside ham (6 in) | 1.02 | | | | | | |
| Viscera wt | 0.06 | | | | | | |

TABLE 9 CONTINUED

| Traits | Equations 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Fat probe 5th thoracic vertebra (6 in) | -.84 | | | | | | |
| Fat probe 4th cervical vertebra (9 in) | -.40 | | | | | | |
| Liver wt | -.13 | | | | | | |
| Fat probe 5th thoracic vertebra (3 in) | -.04 | | | | | | |
| Multiple correlation coefficient (R) | .926 | .900 | .894 | .883 | .867 | .855 | .833 |
| Coefficient of determination ($R^2$) | 85.7 | 81.0 | 79.9 | 78.0 | 75.2 | 73.1 | 69.4 |

presented in the table varying from equation 1 which includes all 27 variables and accounts for 85.7% of the variation to equation 7 which includes only average carcass backfat and itself accounts for 69.4% of the variation in total fat weight. The addition of leaf fat weight to average backfat thickness increased the explained variance by 3.7%. The addition of <u>longissimus dorsi</u> area and chilled carcass weight increased the coefficient of determination to 78.0. As found with the earlier equations, the inclusion of the various fat probes did not increase the explained variance a great deal. The prediction equations for predicting total fat weight are as follows:

Equation 4: Y = 6.41 + 1.61 (average carcass backfat) + 1.32 (leaf fat weight) - 1.81 (<u>longissimus dorsi</u> area) + 0.21 (chilled carcass weight).

Equation 5: Y = 36.26 + 1.68 (average carcass backfat) + 1.29 (leaf fat weight) - 1.47 (<u>longissimus dorsi</u> area).

Both equations are very practical and do predict a large amount of the variation in total fat weight. Lu <u>et</u> <u>al</u>. (1958) reported that they found the combination of a fat probe at the last rib, carcass weight and average carcass backfat to have a multiple correlation coefficient of .919 with carcass fat content.

The one measure that gives the best indication of true carcass value is total pounds of edible portion. However, to obtain the total pounds of edible portion on an entire carcass does involve a great deal of time consuming labor. Thus, if an accurate, practical prediction equation for predicting pounds of edible portion was available, it would indeed be very useful. The partial regression coefficients for each trait used in this study to predict total pounds of E. P. are presented in table 10. According to the results presented in this table, equation 1 which included all 27 variables showed a high multiple correlation coefficient of .923 and did account for 85.2% of the variation in total pounds of E. P. Average carcass backfat alone accounted for 37.9% of the variation. The combination of chilled carcass weight and average carcass backfat showed a multiple correlation coefficient of .885 and thus accounted for nearly 70% (69.7%) of the variation. The addition of <u>longissimus dorsi</u> area to the above two variables increased the explained variance by 4.1%. As indicated by equation 4 in table 10, the combination of average carcass backfat, chilled carcass weight, <u>longissimus dorsi</u> area and animal age at slaughter appears to be a very useful equation and accounted for 77.6% of the variation in total pounds of edible portion. The inclusion of the fat thickness measurement taken one-half the length of the <u>longissimus dorsi</u> muscle in addition to the four measurements listed above only increased the explained variance 1.8%. It is interesting to note that the measurements of leaf fat weight, carcass length and slaughter weight did not greatly increase the multiple correlation coefficients.

These results are in close agreement with Blendl (1966) who reported a high multiple correlation between fat thickness, <u>longissimus dorsi</u> area and the total weight of lean in the carcass. The prediction equations for predicting total pounds of E. P. are as follows:

TABLE 10. PARTIAL REGRESSION COEFFICIENTS FOR EACH TRAIT USED IN PREDICTING POUNDS OF EDIBLE PORTION

| Traits | Equations | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Average carcass backfat | -.75 | -.60 | -.85 | -1.16 | -1.21 | -1.50 | -1.45 |
| Chilled carcass wt | 0.61 | 0.59 | 0.58 | 0.57 | 0.61 | 0.66 | |
| Longissimus dorsi area | 1.46 | 1.80 | 2.23 | 2.70 | 2.01 | | |
| Animal age at slaughter | -.08 | -.08 | -.09 | -.09 | | | |
| Fat cover one-half length of L. D. muscle | -2.64 | -2.43 | -3.44 | | | | |
| Fat probe inside ham (4 in) | 4.11 | 4.79 | | | | | |
| Liver wt | 1.21 | 1.28 | | | | | |
| Fat probe outside ham (8 in) | -4.27 | -4.26 | | | | | |
| Leaf fat wt | -.60 | -.58 | | | | | |
| Fat probe outside ham (4 in) | 6.39 | 5.80 | | | | | |
| Fat probe 4th lumbar vertebra (6 in) | -7.20 | -6.62 | | | | | |
| Carcass length | 0.45 | 0.53 | | | | | |
| Slaughter wt | 0.14 | | | | | | |
| Weight off test | -.18 | | | | | | |
| Viscera wt | -.19 | | | | | | |
| Pluck wt | -.44 | | | | | | |
| Fat probe 4th cervical vertebra (3 in) | 1.34 | | | | | | |
| Fat probe outside ham (6 in) | -2.09 | | | | | | |
| Fat probe 5th thoracic vertebra (9 in) | 1.17 | | | | | | |
| Fat probe 4th cervical vertebra (6 in) | -1.32 | | | | | | |
| Head wt | -.09 | | | | | | |
| Fat cover one-fourth length of L. D. muscle | 0.88 | | | | | | |
| Fat probe 4th cervical vertebra (9 in) | 0.71 | | | | | | |

TABLE 10 CONTINUED

| Traits | Equations 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Fat probe 4th lumbar vertebra (4 in) | -.85 | | | | | | |
| Fat probe 5th thoracic vertebra (6 in) | 0.78 | | | | | | |
| Multiple correlation coefficient (R) | .923 | .913 | .891 | .881 | .869 | .885 | .616 |
| Coefficient of determination ($R^2$) | 85.2 | 83.4 | 79.4 | 77.6 | 73.8 | 69.7 | 37.9 |

Equation 4: Y = 10.89 - 1.16 (average carcass backfat thickness) + 0.57 (chilled carcass weight) + 2.70 (<u>longissimus dorsi</u> area) -.09 (animal age at slaughter).

Equation 5: Y = - 6.37 - 1.21 (average carcass backfat thickness) + 0.61 (chilled carcass weight) + 2.01 (<u>longissimus dorsi</u> area).

Both of these equations appear quite practical and are very accurate in predicting total pounds of E. P. in a carcass.

Table 11 reports the partial regression coefficients for five traits used to predict pounds of primal cuts. These same five traits are used in the tables that follow to predict pounds of lean cuts as well as the total fat, bone and E. P. weight because they are easy to obtain and are usually collected as a routine procedure when evaluating pork carcasses.

As shown in an earlier table, average carcass backfat alone accounted for 38.6% of the variation in pounds of primal cuts. The most practical and useful prediction equation for predicting pounds of primal cuts would appear to be equation 4 because the coefficients of determination increased only 0.5%, 0.7% and 0.9% by adding slaughter weight, carcass length and animal age at slaughter, respectively, to the values of average carcass backfat and chilled carcass weight which were used in equation 4.

The prediction equation for predicting pounds of primal cuts is as follows:

TABLE 11. PARTIAL REGRESSION COEFFICIENTS FOR FIVE TRAITS USED IN PREDICTING POUNDS OF PRIMAL CUTS

| Traits | Equations 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Average carcass backfat | -1.42 | -1.42 | -1.39 | -1.35 | -1.30 |
| Chilled carcass wt | 0.56 | 0.56 | 0.56 | 0.61 | |
| Slaughter wt | 0.08 | 0.09 | 0.07 | | |
| Carcass length | -.24 | -.25 | | | |
| Animal age at slaughter | -.01 | | | | |
| Multiple correlation coefficient (R) | .860 | .859 | .858 | .855 | .621 |
| Coefficient of determination ($R^2$) | 74.0 | 73.8 | 73.6 | 73.1 | 38.6 |

Equation 4: $Y = 10.09 - 1.35$ (average carcass backfat) $+ 0.61$ (chilled carcass weight).

This equation has acceptable accuracy ($R^2 = 73.1$) and thus would appear useful in predicting total weight of the primal cuts in a pork carcass.

Average carcass backfat alone accounted for more of the variation (46.1%) in predicting total pounds of lean cuts (table 12) than it did (38.6%) in predicting pounds of primal cuts. The same pattern is generally true for lean cut weight as for primal cut weight in that equation 4 which contains only two variables appears the most practical in estimating pounds of primal cuts because the coefficients of determination for equations 1, 2 and 3 are only a very small amount

TABLE 12. PARTIAL REGRESSION COEFFICIENTS FOR FIVE TRAITS USED IN PREDICTING POUNDS OF LEAN CUTS

| Traits | Equations 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Average carcass backfat | -1.40 | -1.40 | -1.44 | -1.45 | -1.41 |
| Chilled carcass wt | 0.51 | 0.51 | 0.48 | 0.48 | |
| Carcass length | 0.32 | 0.32 | 0.24 | | |
| Slaughter wt | -.05 | -.05 | | | |
| Animal age at slaughter | 0.00 | | | | |
| Multiple correlation coefficient (R) | .827 | .827 | .826 | .825 | .679 |
| Coefficient of determination ($R^2$) | 68.4 | 68.4 | 68.2 | 68.1 | 46.1 |

greater than that of equation 4. Equation 4 for predicting pounds of lean cuts is as follows:

Equation 4: Y = 10.71 - 1.45 (average carcass backfat) + 0.48 (chilled carcass weight).

Table 13 reports the partial regression coefficients for the five traits used in predicting total pounds of fat. It is interesting to note that average backfat thickness alone accounted for 69.4% of the variation in total carcass fat weight and that the addition of the other four variables only increased the coefficient of determination to 72.4%. Based on the coefficients of determination, the most practical prediction equation would appear to be number 4. Equation 4 for predicting total pounds of fat in the carcass is as follows:

TABLE 13. PARTIAL REGRESSION COEFFICIENTS FOR FIVE TRAITS USED IN PREDICTING TOTAL POUNDS OF FAT

| Traits | Equations 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| verage carcass backfat | 1.99 | 2.01 | 2.04 | 2.04 | 2.05 |
| hilled carcass wt | 0.15 | 0.18 | 0.17 | 0.15 | |
| nimal age at slaughter | 0.05 | 0.05 | 0.05 | | |
| arcass length | -.48 | -.41 | | | |
| laughter wt | 0.04 | | | | |
| ultiple correlation coefficient (R) | .851 | .851 | .849 | .843 | .833 |
| oefficient of determination ($R^2$) | 72.4 | 72.4 | 72.1 | 71.1 | 69.4 |

Equation 4: Y = 11.22 + 2.04 (average carcass backfat) + 0.15 (chilled carcass weight).

Table 14 shows the regression coefficients for the five traits sed for predicting total bone weight. The coefficients of deterination ranged from 33.6 for backfat thickness alone to 52.3 when verage carcass backfat, chilled carcass weight, carcass length, animal ge at slaughter and slaughter weight were used. Because of the low oefficients of determination, prediction equations were not alculated for total bone weight.

The partial regression coefficients for the five traits used n predicting pounds of E. P. are listed in table 15. The combination f all five carcass measures showed a coefficient of determination of 1.7 as compared to a value of 69.7 for average carcass backfat and

TABLE 14. PARTIAL REGRESSION COEFFICIENTS FOR FIVE TRAITS USED IN PREDICTING TOTAL POUNDS OF BONE

| Traits | Equations 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Average carcass backfat | -.35 | -.36 | -.36 | -.39 | -.38 |
| Chilled carcass wt | 0.13 | 0.12 | 0.11 | 0.12 | |
| Carcass length | 0.35 | 0.33 | 0.35 | | |
| Animal age at slaughter | 0.01 | 0.01 | | | |
| Slaughter wt | -.02 | | | | |
| Multiple correlation coefficient (R) | .723 | .721 | .716 | .691 | .580 |
| Coefficient of determination ($R^2$) | 52.3 | 52.0 | 51.3 | 47.7 | 33.6 |

TABLE 15. PARTIAL REGRESSION COEFFICIENTS FOR FIVE TRAITS USED IN PREDICTING POUNDS OF EDIBLE PORTION

| Traits | Equations 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Average carcass backfat | -1.53 | -1.55 | -1.51 | -1.50 | -1.45 |
| Chilled carcass wt | 0.59 | 0.59 | 0.64 | 0.66 | |
| Animal age at slaughter | -.05 | -.05 | -.05 | | |
| Slaughter wt | 0.07 | 0.08 | | | |
| Carcass length | 0.21 | | | | |
| Multiple correlation coefficient (R) | .847 | .846 | .843 | .835 | .616 |
| Coefficient of determination ($R^2$) | 71.7 | 71.6 | 71.1 | 69.7 | 37.9 |

chilled carcass weight. Average carcass backfat alone showed a multiple regression coefficient of .616 and did account for 37.9% of the variation in weight of total E. P. Equation 4 appears the most practical and would appear to be useful in predicting total pounds of E. P. which is an excellent indicator of carcass value. Equation 4 for predicting pounds of E. P. is as follows:

Equation 4: Y = 0.37 - 1.50 (average carcass backfat) + 0.66 (chilled carcass weight).

Table 16 shows partial regression coefficients for four commonly used measures of carcass value. Nearly every carcass show reports the average carcass backfat, longissimus dorsi area, carcass length and percent ham and loin. It is very interesting to note that the combination of these four popular measures of carcass value do not account for even 50% of the variation in yield of E. P. The table also indicates that carcass length and percent ham and loin are essentially of no value when predicting E. P. weight because average carcass backfat and longissimus dorsi area do have a coefficient of determination of 47.3 and the addition of percent ham and loin and carcass length only increased the value to 47.8.

TABLE 16. PARTIAL REGRESSION COEFFICIENTS FROM FOUR COMMONLY USED VARIABLES USED IN PREDICTING TOTAL POUNDS OF EDIBLE PORTION

| Traits | Equations 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Average carcass backfat | -.95 | -.97 | -1.00 | -1.45 |
| Longissimus dorsi area | 2.93 | 2.97 | 3.01 | |
| Carcass length | 0.49 | 0.50 | | |
| Percent ham and loin of chilled carcass wt | 0.04 | | | |
| Multiple correlation coefficient (R) | .692 | .692 | .688 | .616 |
| Coefficient of determination ($R^2$) | 47.8 | 47.8 | 47.3 | 37.9 |

## SUMMARY AND CONCLUSIONS

This project evaluated 27 carcass measurements which were used to estimate the total pounds of edible portion in a pork carcass. The 150 crossbred pigs used in this study weighed an average of 203.17 ± 5.08 pounds and were 160.8 ± 11.02 days of age at slaughter. The group had an average carcass backfat of 1.39 inches and a longissimus dorsi area of 4.51 square inches.

The measurements used in an attempt to estimate carcass cutout value were animal age at slaughter, weight off test, slaughter weight, carcass length, average carcass backfat, longissimus dorsi area and chilled carcass weight. In addition, head weight, viscera weight, liver weight, pluck weight, leaf fat weight and several fat probe measurements were collected and used. Both sides of each carcass were separated into edible portion, fat and bone components. Simple and multiple correlation coefficients, coefficients of determination as well as partial regression coefficients were calculated. When the coefficients of determination were greater than 50% and when practical equations appeared feasible, prediction equations were calculated.

Correlation coefficients between total edible portion weight and leaf fat weight, average carcass backfat and longissimus dorsi area were -.42 ($P<.01$), -.62 ($P<.01$) and 0.58 ($P<.01$), respectively. The two fat thickness measurements taken between the 12th and 13th ribs at one-fourth and one-half the length of the longissimus dorsi muscle from the chine bone end showed high correlation coefficients with total edible portion weight ($r = -.56$ and $-.56$). The highest correlation coefficients between the various fat probes and pounds of edible portion were the probes taken in the area of the lumbar vertebrae ($r = -.43$ and $-.48$). Correlation coefficients between average carcass backfat and the fat thickness one-fourth and one-half the length of the longissimus dorsi muscle were 0.75 and 0.71, respectively.

Simple correlation coefficients between longissimus dorsi area and weight of primal cuts, weight of lean cuts, percent ham and loin, total bone and total fat weight were 0.84 ($P<.01$), 0.81 ($P<.01$), 0.55 ($P<.01$), 0.51 ($P<.01$) and -.69 ($P<.01$), respectively.

The prediction equation which appeared the most useful and practical for estimating total fat weight involved the use of average carcass backfat, leaf fat weight, longissimus dorsi area and chilled carcass weight. These four measures showed a multiple correlation coefficient of .883 and a coefficient of determination of 78.0.

The one measure that gave the best indication of carcass meatiness was total pounds of edible portion. One of the objectives of this study was to determine how accurately we could predict total pounds of edible portion. The equation (total pounds of edible portion) = 10.89 - 1.16 (average carcass backfat thickness) + 0.57 (chilled carcass weight) + 2.70 (longissimus dorsi area) -.09 (animal age at slaughter) had a multiple correlation coefficient of .881 and a coefficient of determination of 77.6. This equation appeared very practical and with the use of these four carcass measurements gave a reliable estimate of the total pounds of edible portion in a pork carcass.

In all of the regression analyses to predict weight of primal cuts, weight of lean cuts, percent ham and loin, total bone weight, total fat weight and total edible portion weight, average carcass backfat accounted for the largest single amount of variation that did exist.

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